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Low latitude dynamics and secular variation in rapidly-rotating convection driven dynamos

ANDREY SHEYKO[1], CHRISTOPHER FINLAY [2], PHILIPPE MARTI[3] & ANDREW JACKSON[4]

[1] Earth and Planetary Magnetism group, Institute of Geophysics, Swiss Federal Institute of Technology Zurich, Zurich, Switzerland
(andrey.sheyko@erdw.ethz.ch)
[2] National Space Institute, Technical University of Denmark, Copenhagen, Denmark
(cfinlay@space.dtu.dk)
[3] Department of Applied Mathematics, University of Colorado, Boulder, USA
(Philippe.Marti@colorado.edu)
[4] Earth and Planetary Magnetism group, Institute of Geophysics, Swiss Federal Institute of Technology Zurich, Zurich, Switzerland
(ajackson@ethz.ch)

Motions of liquid metal inside the Earth's outer core are responsible for generating the geomagnetic field in a dynamo process. Prominent features in the observed core surface field are intense equatorial flux patches drifting westwards at a rate of 17km/yr. We investigate the formation and dynamics of such flux features in numerical dynamo models, varying the convection strength. We study a set of numerical dynamo models varying the convection strength by a factor of 30 and ratio of magnetic to viscous diffusivities by a factor of 20 at fixed rapid rotation rate ($E = \nu/(2\Omega d^2) = 10^{-6}$) using a heat flux outer BC. This regime has been little explored (aside from a pioneering study by Sakuraba & Roberts) due to the significant computing resources required. Our simulations are carried out using a discretisation of degree and order 256 in spherical harmonics, and 516 finite difference points in radius and parallelized on 516 processors. We present an analysis of the time-evolution and force balance associated with low-latitude magnetic flux concentrations. We also report a comparison of our results with the proposed rotating convection and dynamo scaling laws.